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[Inventor]
[Address] c/o Yamaha Hatsudoki Kabushiki Kaisha 2500 Shingai, Iwata-shi, Shizuoka-ken, Japan
[Name] Tsuide YANAGIHARA
[Inventor]
[Address] c/o Yamaha Hatsudoki Kabushiki Kaisha 2500 Shingai, Iwata-shi, Shizuoka-ken, Japan
[Name] Ryoichi NAKASE
[Inventor]
[Address] c/o Yamaha Hatsudoki Kabushiki Kaisha 2500 Shingai, Iwata-shi, Shizuoka-ken, Japan
[Name] Yutaka MIZUNO
[Applicant]
[Identification No.] 000010076
[Name] Yamaha Hatsudoki Kabushiki Kaisha
[Agent]
[Identification No.] 100064621
[Patent Attorney]
[Name] Masaki YAMAKAWA
[Telephone No.] 03-3580-0961
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[Title of the Invention]

STEERING ASSIST SYSTEM FOR A BOAT

[Claims]

1. A steering assist system for a boat comprising:

a regulating means for regulating the turning range of a steering system of the boat, the regulating means including a movable stopper mounted to a movable member of the steering system, a fixed stopper for stopping the movement of the movable stopper, and load cells interposed between the movable and the fixed stoppers; and

a control system for increasing a thrust produced by a propulsion device according to an output from each of the load cells.

2. The steering assist system for a boat according to Claim 1, wherein the propulsion device is a water jet propulsion device, and wherein the steering system is arranged such that handlebars are turned in conjunction with a nozzle deflector of the water jet propulsion device, the movable stopper being mounted to the turning shaft of the handlebars.

3. The steering assist system for a boat according to Claim 2, wherein auxiliary deflectors for changing the direction of the flow of water discharged in a jet from the nozzle deflector are laterally turnably provided on the nozzle deflector, and wherein the control system is arranged to control the turning angle of the auxiliary deflectors according to an output from each of the load cells.

4. A steering assist system for a boat comprising:

a steering system of the boat with a water jet propulsion device mounted arranged such that handlebars are turned in conjunction with a nozzle deflector of the water jet propulsion device;

a regulating means for regulating the turning range of the steering system, the regulating means including a movable stopper mounted to a movable member of the steering system, a fixed stopper for stopping the movement of the movable stopper, and load cells interposed between the movable and the fixed stoppers;

auxiliary deflectors laterally turnably provided on the nozzle deflector, for changing the direction of the flow of water discharged in a jet from the nozzle deflector; and

a control system for controlling the turning angle of

the auxiliary deflectors according to an output from each of the load cells.

5. A steering assist system for a boat comprising:

a regulating means for regulating the turning range of a steering system of the boat, the regulating means including a movable stopper mounted to a movable member of the steering system, a fixed stopper for stopping the movement of the movable stopper, and load cells interposed between the movable and the fixed stoppers;

rudders provided to be vertically movable for changing the running direction of the boat; and

a control system for controlling the vertical movement of the rudders according to an output from each of the load cells.

6. The steering assist system for a boat according to Claim 5, wherein the propulsion device is a water jet propulsion device, and wherein the steering system is arranged such that handlebars are turned in conjunction with a nozzle deflector of the water jet propulsion device, the movable stopper being mounted to the turning shaft of the handlebars.

7. The steering assist system for a boat according to Claim 6, wherein the rudders are provided on the nozzle deflector to be vertically movable.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

This invention relates to a steering assist system for improving the steerability of a boat.

[0002]

[Prior Art]

Generally, boats change direction by a helm. It is known that the turning characteristics of the boats are determined by the component of lift force produced based on the difference in water pressure between the surfaces of the helm when the water flow produced by a propulsion unit or by the boat running acts on the helm (see Patent Document #1). Further, the conventional boats driven by a water jet propulsion device change direction by a reaction force exerted against a jet flow produced by the propulsion device. In the case of these types of boats, it is known that the steerability is degraded when the rate of jet flow produced by the water jet propulsion device (the amount of reaction force) is relatively lower than the boat speed.

[0003]

Accordingly, in those conventional types of boats, in order to swiftly change direction when the boat is running at a slight speed, such as when docking, a throttle valve is opened simultaneously with the operation of handlebars to temporarily increase an engine output. Thus operating the throttle valve increases a thrust with the nozzle deflector of an outboard motor or the water jet propulsion device turned in the desired direction, so that the running direction of the hull is swiftly changed.

[0004]

However, there arises a problem that operating the throttle simultaneously with the steering as described above, makes the boat operation complicated.

The boats in which an output from the propulsion device is increased in conjunction with the steering are disclosed, for example, in Patent Document #2 and Patent Document #3 as will be described later. The steering assist system provided in these conventional types of boats is arranged such that the output from the propulsion device is increased when the turning angle of the handlebars becomes greater than a preset angle.

Incidentally, the applicant was unable to discover prior art literature related to the present invention other than those specified herein as prior art literature information, prior to the application.

[0005]

[Patent Document #1]

JP-A-S57-84297

[Patent Document #2]

JP-A-2001-32988

[Patent Document #3]

US6336833

[0006]

[Problems to be Solved by the Invention]

However, in the foregoing steering assist system, when the rider turns the handlebars by a predetermined angle, the output from the propulsion device is automatically increased. Thus, an undesired thrust may be produced against the rider's will, and the boat operation cannot necessarily be performed in a natural manner. There has arisen the need for the steering assist system to assist the rider to operate the boat in a natural manner without any special concern for the throttle operation.

[0007]

In view of the foregoing, it is an object of this invention to provide a steering assist system for a boat to assist the rider to operate the boat in a natural manner

without any concern for the throttle operation.

[0008]

[Means for Solving the Problems]

In order to achieve the foregoing object, the invention is a steering assist system for a boat comprising: a regulating means for regulating the turning range of a steering system of the boat, the regulating means including a movable stopper mounted to a movable member of the steering system, a fixed stopper for stopping the movement of the movable stopper, and load cells interposed between the movable and the fixed stoppers; and a control system for increasing a thrust produced by a propulsion device according to an output from each of the load cells.

[0009]

According to the invention, when the steering system is turned either right or left by a maximum turning angle and then further turned with a greater than usual force, the force is detected by the corresponding load cell to increase the thrust produced by the propulsion device.

[0010]

The invention of Claim 2 is the steering assist system for a boat according to Claim 1, in which the propulsion device is a water jet propulsion device, and in which the steering system is arranged such that handlebars are turned in conjunction with a nozzle deflector of the water jet propulsion device, the movable stopper being mounted to the turning shaft of the handlebars.

According to the invention of Claim 2, when the handlebars are turned either right or left by a maximum turning angle and then further turned with a greater than usual force, the force is detected by the corresponding load cell to increase the thrust produced by the water jet propulsion device.

[0011]

The invention of Claim 3 is the steering assist system for a boat according to Claim 2, in which auxiliary deflectors for changing the direction of the flow of water discharged in a jet from the nozzle deflector are laterally turnably provided on the nozzle deflector, and in which the control system is arranged to control the turning angle of the auxiliary deflectors according to an output from each of the load cells.

[0012]

According to the invention of Claim 3, when the handlebars are turned either right or left by a maximum turning angle and then further turned with a greater than usual force, the amount of water discharged in a jet from the nozzle deflector is increased and the flow of the

discharged jet of water is changed in direction by the auxiliary deflectors, so that the substantial steering angle is increased.

[0013]

The invention of Claim 4 is a steering assist system for a boat comprising: a steering system of the boat with a water jet propulsion device mounted arranged such that handlebars are turned in conjunction with a nozzle deflector of the water jet propulsion device; a regulating means for regulating the turning range of the steering system, the regulating means including a movable stopper mounted to a movable member of the steering system, a fixed stopper for stopping the movement of the movable stopper, and load cells interposed between the movable and the fixed stoppers; auxiliary deflectors laterally turnably provided on the nozzle deflector, for changing the direction of the flow of water discharged in a jet from the nozzle deflector; and a control system for controlling the turning angle of the auxiliary deflectors according to an output from each of the load cells.

[0014]

According to the invention of Claim 4, when the steering system is turned either right or left by a maximum turning angle and then further turned with greater force than usual, the force is detected by the corresponding load cell and the flow of water discharged in a jet from the nozzle deflector is changed in direction by the auxiliary deflectors, so that the substantial steering angle is increased.

[0015]

The invention of Claim 5 is a steering assist system for a boat comprising: a regulating means for regulating the turning range of a steering system of the boat, the regulating means including a movable stopper mounted to a movable member of the steering system, a fixed stopper for stopping the movement of the movable stopper, and load cells interposed between the movable and the fixed stoppers; rudders provided to be vertically movable for changing the running direction of the boat; and a control system for controlling the vertical movement of the rudders according to an output from each of the load cells.

[0016]

According to the invention of Claim 5, when the steering system is turned either right or left by a maximum turning angle and then further turned with greater force than usual, the force is detected by the corresponding load cell to lower the rudders. Meanwhile, when the boat runs with no steering force produced by the steering system, the

rudders go back up to the retracted position. Therefore, since the rudders are back up to the retracted position when the boat is running with no steering force produced, even if the boat runs in shallow waters, the rudders are prevented from contacting obstacles under the sea. Thus, the rudders cause no problem in the shallow water running.

[0017]

The invention of Claim 6 is the steering assist system for a boat according to Claim 5, in which the propulsion device is a water jet propulsion device, and in which the steering system is arranged such that handlebars are turned in conjunction with a nozzle deflector of the water jet propulsion device, the movable stopper being mounted to the turning shaft of the handlebars.

According to the invention of Claim 6, when the handlebars are turned either right or left by a maximum turning angle and then further turned with a greater than usual force, the force is detected by the corresponding load cell to lower the rudders.

[0018]

The invention of Claim 7 is the steering assist system for a boat according to Claim 6, in which the rudders are provided on the nozzle deflector to be vertically movable.

According to the invention of Claim 7, since the rudders are turned right and left along with the nozzle deflector, an operating mechanism especially for turning the rudders right and left can be eliminated.

[0019]

[Embodiments of the Invention]

(First Embodiment)

An embodiment of a steering assist system for a boat according to the invention will be described below in detail with reference to Fig. 1 to Fig. 4. Here, descriptions will be made by taking an example of a steering assist system provided in a small planing boat.

Fig. 1 is a plan view of a small planing boat equipped with a steering assist system according to the invention, in which a handlebars regulating means is drawn by solid lines to facilitate understanding. Fig. 2 is a perspective view of a constitution of the steering assist system according to the invention. Fig. 3 is a block diagram of the constitution of the same. Fig. 4 is a flowchart for explaining the operation of the steering assist system according to the invention.

[0020]

In the drawings, reference numeral 1 denotes the small planing boat equipped with a steering assist system 2 of the embodiment. This small planing boat 1 has a seat 5 for

a rider to straddle and handlebars 6 for the rider to grip provided in a deck 4 over a hull 3, and a water jet propulsion device 7 mounted within the hull 3. In Fig. 1, reference numeral 8 denotes each footstep for the rider to place his/her foot formed on the periphery of the seat 5.

[0021]

The water jet propulsion device 7, as has conventionally been well known, is constituted of an engine 11 and a jet pump 12 and arranged such that water is drawn up in from the bottom of the hull 3 by the power of the engine 11 and discharged in a jet rearward from a nozzle deflector 13 provided at the rear end of the jet pump 12 to obtain thrust. The nozzle deflector 13 is laterally swingably supported at the rear end of the jet pump 12 and, as shown in Fig. 2, connected to a steering arm 15 of the handlebars 6 through a push-pull wire 14 as will be described later.

[0022]

The engine 11 is a multicylinder engine disposed with the axis of its crankshaft 21 (see Fig. 1) longitudinally oriented with respect to the hull 3 and is connected to an air intake system 22 on the right and an exhaust system (not shown) on the left, with respect to the hull. The air intake system 22 is arranged such that fuel is supplied to an air intake passage for each cylinder by a carburetor 23 (see Fig. 2) or an injector (not shown) and a throttle valve 24 is provided for each of the cylinders.

[0023]

The throttle valves 24 are interlocked together. Among these, the foremost throttle valve 24 (shown in Fig. 2) with respect to the hull is connected to a throttle lever 25 of the handlebars 6 through a throttle wire 26. Operating the throttle lever 25 thus opens/closes all the throttle valves 24 in conjunction together. Incidentally, each of the throttle valves 24 is urged by a return spring (not shown) in the closing direction.

[0024]

Further, the engine 11 is provided with an engine speed sensor 27 (see Fig. 3) for detecting the rotational speed of the crankshaft 21. The sensor 27 sends out engine speed data to a controller 28 of the steering assist system 2 as will be described later.

[0025]

The handlebars 6 are constituted of a handlebar 29 gripped by the rider, a steering shaft 31 with the handlebar 29 mounted at the upper end by clamps 30, a steering bearing 32 with the steering shaft 31 fitted in and rotatably supported, a mounting plate 33 for fixing the

steering bearing 32 to the deck 4, and the like, as shown in Fig. 2.

To the upper end of the steering shaft 31 is welded a load cell arm 35 constituting part of a regulating means 34 for regulating the turnable range of the handlebars 6.

[0026]

The regulating means 34 is constituted of the projecting load cell arm 35, as a stopper piece, formed in the steering shaft 31 toward the front of the hull 3, load cells 36 disposed midway in the turning locus traced by the steering shaft 31 with the load cell arm 35, the mounting plate 33, as a pressure receiving member, for supporting the load cells 36, and the like. According to the regulating means 34, the turnable range of the steering shaft 31 is regulated in such a way that the load cell arm 35 comes in contact with a probe 36a of each of the load cells 36.

[0027]

As shown in Fig. 3, the load cells 36 are of magnetostrictive type, with a coil 36b wound on each of the probes 36a of magnetic bodies and are connected to the controller 28 of the steering assist system 2 as will be described later. When each of the load cells 36 at the probe 36a is pressed by the load cell arm 35, the impedance produced by the coil is changed in approximate proportion to the load applied to the handlebars. The change in impedance is detected by the controller 28 as will be described later. Incidentally, the load cells 36 are not limited to those of mangetostrictive type but those of other types, strain gauge type, for example, can also be used.

[0028]

The steering shaft 31 at the lower end is connected to the steering push-pull wire 14 through the steering arm 15, and the throttle wire 26 is inserted in the axial center of the steering shaft 31, as shown in Fig. 2.

The push-pull wire 14 connected to the steering arm 15 is arranged such that an inner wire 14b is inserted in an outer tube 14a, the ends of which are supported by holders 37, 38 against the hull 3. That is, when the handlebar 29 is turned right or left, the steering arm 15 is turned in the same direction, so that the inner wire 14b is pushed or pulled to swing the nozzle deflector 13 right or left.

[0029]

The throttle wire 26 inserted in the axial center of the steering shaft 31 has an inner wire 26b inserted in an outer tube 26a, and the inner wire 26b at an end is connected to a pulley 24a for driving the throttle valves

24. The outer tube 26a of the throttle wire 26 has an end clamp 39 at the end on the throttle valves 24 side. The end clamp 39 is supported by an arm 42 of a throttle operating servomotor 41.

[0030]

Therefore, when the arm 42 of the servomotor 41 is swung, the end clamp 39 is changed in position, so that the inner wire 26b at the end on the throttle valves 24 side can be pulled or pulled back. In this embodiment, when the arm 42 is swung in the direction shown in Fig. 2 by arrow A, the end of the inner wire 26b on the throttle valves 24 side is pulled, so that the throttle valves 24 are opened without operating the throttle lever 25. Also, when the arm 42 is swung in the opposite direction (shown by arrow B), the inner wire 26b is pulled back to close the throttle valves 24.

[0031]

The servomotor 41 having the arm 42 is arranged such that the drive of a motor 43 is reduced in speed by a speed reducer 44 and transmitted to the arm 42, as shown in Fig. 3, and it is driven by the feedback control of the steering assist system 2 as will be described later. The feedback control is performed in such a way that an actual swing angle of the arm 42 is detected by a feedback potentiometer 45 provided in the arm 42 and the motor 43 is driven until the actual swing angle matches a target angle of the arm 42 set by the steering assist system 2.

[0032]

The steering assist system 2 is designed to improve the steerability of the boat during low speed running. As shown in Fig. 2 and Fig. 3, it is constituted of the controller 28 connected to the load cells 36 and engine speed sensor 27, the throttle operating servomotor 41 controlled by the controller 28, and the like, and is powered by a battery 46.

The controller 28 is constituted of a load cell amplifier 47 for detecting the change in impedance of each of the load cells 36 and determining it as a detected value corresponding to the load applied to each of the load cells 36, a servomotor controller 48 for driving the servomotor 41 based on the detected value, and the like.

[0033]

The servomotor controller 48 employs a circuit to perform steering control, as will be described later, when the detected value determined by the load cell amplifier 47 is greater than a preset load. The preset load is set at the load applied to the corresponding load cell 36 when the handlebar 29 is turned right or left to the full (until the

steering is regulated by the regulating means 34) and then further turned with greater force than usual required to turn the handlebar 29 in steering. Incidentally, the circuit in the servomotor controller 48 is arranged not to detect the shock load applied to each of the load cells 36 when the load cell arm 35 contacts the probe 36a of each of the load cells 36, such as when the rider abruptly steers the boat. That is, according to the steering assist system 2, when the handlebars 6 are turned right or left until the steering is regulated by the regulating means 34 and then further turned with greater force than usual while the small planing boat 1 is running at a low speed, the servomotor controller 48 starts steering control as will be described later.

[0034]

The steering control performed by the servomotor controller 48 is accomplished in such a way that the detected value F corresponding to the load applied to each of the load cells 36 multiplied by a gain k is determined as a target angle θ of the arm 42 of the servomotor 41 and the servomotor 41 is feedback-controlled until the target angle is reached. That is, according to the steering control, the throttle valves 24 are opened by a degree according to an output from each of the load cells 36 (the force applied to the handlebars 6 by the rider), and the output of the engine 11 is controlled. Incidentally, the target angle is an angle by which the arm 42 is swung in the direction of the throttle valves 24 being increased in opening when the inner wire 26b of the throttle wire 26 is pulled.

[0035]

Next, the operation of the foregoing steering assist system 2 will be described more in detail with reference to the flowchart of Fig. 4.

In the servomotor controller 48, the load cell amplifier 47 first determines by calculation a detected value corresponding to the load applied to each of the load cells 36 based on the impedance of each of the load cells 36, as shown at step S1 of Fig. 4. Then, the load cell amplifier 47 determines whether or not the detected value is greater than the preset load at step S2.

Procedure returns to the step S1 when the result of the determination is NO, that is, when the boat is moving straight or making a gradual turn, or when the handlebars 6 has been turned right or left until the steering is regulated by the regulating means 34 yet with only an equal to usual force applied to the handlebars 6.

[0036]

On the other hand, when the result of the determination is YES, that is, when the handlebars 6 are turned either right or left until the steering is regulated by the regulating means 34, and then further kept being urged in the same direction with a greater than usual force (when the steering is being performed intentionally), the procedure goes to step S5, and the servomotor controller 48 calculates a target angle θ of the arm 42 of the servomotor 41 by multiplying the detected value F by a gain k.

Thereafter, the servomotor controller 48 drives the servomotor 41 at step S4 and then determines whether or not the actual swing angle of the arm 42 of the servomotor 41 reaches the target angle at step S5. When the result of the determination is NO at the step S5, the procedure returns to the step S4, while when YES, the procedure goes to step S6 at which the servomotor controller 48 stops the servomotor 41.

[0037]

When the servomotor 41 is driven as shown at the steps S4 to S6, the inner wire 26b of the throttle wire 26 is pulled to increase the throttle valves 24 in opening, so that the speed of the engine 11 is increased. As a result, the amount of water discharged in a jet from the water jet propulsion device 7 is increased, and namely, steerability is improved. The speed of the engine 11 at this time is increased or decreased according to the amount of force applied to the handlebars 6 by the rider.

[0038]

After the servomotor 41 is driven as described above, the load cell amplifier 47 again measures the load applied to each of the load cells 36 and determines it as the detected value at step S7, and the servomotor controller 48 determines whether or not the detected value is smaller than the preset value at step S8.

When the result of the determination is NO, that is, when the handlebars 6 are kept being urged by the rider with greater force than usual, the procedure returns to the step S3 to repeat the foregoing control. The result of the determination is YES, that is, when the hull 3 has been changed in running direction due to the increased engine speed and less force is thus being applied to the handlebars 6 by the rider, the procedure goes to step S9 at which the servomotor controller 48 returns the arm 42 of the servomotor 41 to its initial position. When the servomotor 41 is thus driven, each of the throttle valves 24 is returned to its initial opening position (the position prior to the increase due to the steering control), so that the boat starts to run at the prior speed

to the steering control being performed.

[0039]

In such a manner as described, in the small planing boat 1 equipped with the steering assist system 2 with the foregoing arrangement, when the handlebars 6 are turned right or left up to an end position within their turnable range and then further turned with greater force than usual, the force is detected by the corresponding load cell 36 to increase the output of the engine 11. Therefore, only a motion naturally made by the rider steering the boat in an attempt to make a swifter turn than the ongoing turn, increases the output of the engine 11. This makes it possible for the rider to operate the boat in a natural manner without any concern for the throttle operation.

[0040]

Further, even if the handlebars 6 are mistakenly turned, no output of the engine 11 is unnecessarily increased when no load is detected from each of the load cells 36. The output of the engine 11 is thus increased only when the handlebars 6 are turned at the rider's will.

[0041]

(Second Embodiment)

The engine output adapted to be increased due to the steering control of the steering assist system can be changed in the amount of increase according to the engine speed during the steering control.

The constitution of the steering assist system with such an arrangement will be described with reference to the flowchart of Fig. 5.

Fig. 5 is a flowchart for explaining another embodiment of the steering assist system. In the drawing, like or equivalent components are denoted by the same reference numerals as in Fig. 4, and detailed descriptions will be omitted as appropriate.

[0042]

A steering assist system 2 of this embodiment is arranged such that a comparison is made between the current engine speed and a preset docking control engine speed when steering control is performed, and a gain k for determining a target angle θ of a servomotor 41 is changed between when the current engine speed is higher and when lower than the docking control engine speed.

[0043]

The docking control engine speed is set at the engine speed of the boat when it runs at a slow speed for docking. The gain k is set at kA, as the relatively large gain, when the engine speed is relatively high, while kB, as the relatively small gain, when the engine speed is relatively

low. That is, when the engine speed is lower than the docking control engine speed, the amount of increase in engine output due to the steering control becomes relatively small, while when higher, relatively large.

[0044]

The operation of the steering assist system of this embodiment will be described in detail with reference to the flowchart of Fig. 5. The same control is performed as in the foregoing embodiment up to step S2 of Fig. 5, at which the determination is made whether or not the load measured by each of the load cells 36 is greater than a preset value. When the result of the determination is NO, procedure returns to step S1, while when YES, it goes to step S2A and the determination is made whether or not the engine speed is greater than the docking control engine speed.

[0045]

When the result of the determination is YES, that is, when the engine speed is greater than the docking control engine speed, the procedure goes to step S2B, and then to step S3 after kA, as the relatively large gain k, is chosen. On the other hand, when the result of the determination is NO, the procedure goes to step S2C, and then to the step S3 after kB, as the relatively small gain k, is chosen.

Then, the steering assist system 2, as is the case with the first embodiment, calculates a target angle θ based on the gain kA or kB at the step S3, and controls a throttle operating servomotor 41 at step S4 and thereafter.

[0046]

Accordingly, employing this embodiment can increase or decrease the output of the engine 11 adapted to be controlled according to an output from each of the load cells 36, based on the current engine speed. Therefore, at the time of docking, when the boat speed is relatively high, steerability is improved to make the boat swiftly change its running direction, while when relatively low, gradual steering is made possible to make the boat easily and slightly change its running direction.

[0047]

(Third Embodiment)

The small planing boats of the first and the second embodiments may have auxiliary deflectors provided on a nozzle deflector as shown in Fig. 6 to Fig. 8.

Fig. 6 is a perspective view of a constitution of the steering assist system equipped with the auxiliary deflectors. Fig. 7 is a perspective view, on an enlarged scale, of the auxiliary deflectors. Fig. 8 is a plan view

for explaining the operation of the nozzle deflector and auxiliary deflectors, in which (a) shows when the boat is running straight, (b) shows when the boat is turning without the auxiliary deflectors being actuated, and (c) shows when the boat is turning with the auxiliary deflectors being actuated. In the drawings, like or equivalent components are denoted by the same reference numerals as in Fig. 1 to Fig. 5, and detailed descriptions will be omitted as appropriate.

[0048]

A nozzle deflector 13 shown in Fig. 6 to Fig. 8 has auxiliary deflectors 51, 52 laterally turnably mounted on the left and right sides of the front. These auxiliary deflectors 51, 52 are designed to change the direction of the flow of water discharged in a jet from the nozzle deflector 13, which are formed together in a U-shaped section and supported by the nozzle deflector 13 about spindles 53 at the two of the upper and lower positions of the front ends. The spindle 53 is screwed in each boss 54 of the nozzle deflector with its axis vertically oriented. Further, the left auxiliary deflector 51 and the right auxiliary deflector 52 are interlocked together by a coupling link 55 at the longitudinal midway portions.

[0049]

Furthermore, projecting arms 51a, 52a are formed in the auxiliary deflectors 51, 52 at the front ends on the lateral center sides, and an auxiliary deflector servomotor 57 (see Fig. 6) is connected to the arms 51a, 52a through push-pull wires 56. In this embodiment, the push-pull wires 56 for the respective auxiliary deflectors 51, 52 are connected to a single pulley 58 of the servomotor 57, and both the auxiliary deflectors 51, 52 are arranged to be turned by the same angle in the same direction. The push-pull wires 56 at the rear ends of outer tubes 56a are fixed in the vicinity of a turning shaft 13a of the nozzle deflector 13 by a holder 56b so that they are not affected by the turning of the nozzle deflector 13.

[0050]

The servomotor 57 is connected to a controller 28 of a steering assist system 2 and driven by the controller 28 along with a throttle operating servomotor 41 when steering control is performed. That is, the servomotor 57 is driven by the controller 28 when a handlebar 29 is turned right or left to the full (until the steering is regulated by a regulating means 34) and then further turned with greater force than usual required to turn the handlebar 29 in steering.

[0051]

In controlling the auxiliary deflector servomotor 57, the controller 28 detects the turning direction of handlebars 6 based on an output from each load cell 36 and drives the servomotor 57 in the direction corresponding to the detected turning direction. The driving direction of the servomotor 57, in the case that the handlebars 6 are turned right to turn the hull right, for example, is the direction in which both the auxiliary deflectors 51, 52 at the rear ends are displaced relatively right (see Fig. 8 (c)). When the auxiliary deflectors 51, 52 are thus turned, the turning angle thereof formed with respect to the hull is greater than that of the nozzle deflector 13.

[0052]

Further, the drive angle of the servomotor 57 (the turning angle of the auxiliary deflectors 51, 52) at this time is set at the angle corresponding to the amount of load applied to each of the load cells 36. That is, when a relatively large force is applied to the handlebars 6 by the rider, the auxiliary deflectors 51, 52 are turned by a relatively large angle, while when a relatively small force is applied to the handlebars 6, the turning angle of the auxiliary deflectors 51, 52 becomes relatively small.

[0053]

In the small planing boat thus provided with the auxiliary deflectors 51, 52, at the time of a straight run, for example, the nozzle deflector 13 and the auxiliary deflectors 51, 52 are at the same angle with respect to the hull as shown in Fig. 8 (a). When the handlebars 6 are turned right, for example, by a maximum turning angle, the nozzle deflector 13 is turned as shown in Fig 8 (b). That is, when the load applied to each of the load cells 36 is relatively small (smaller than the load at which the steering control is to be started), the auxiliary deflectors 51, 52 are turned together with the nozzle deflector 13 to form the same angle.

[0054]

Further, when the handlebars 6 are turned right by a maximum turning angle and then further turned with greater force than usual, and the load at which the steering control is to be started is applied to the corresponding load cell 36, the auxiliary deflectors 51, 52 are turned by an angle corresponding to the amount of the applied load in the turning direction of the handlebars 6, as shown in Fig. 8 (c). Fig. 8 (c) shows when the handlebars 6 are turned right. Incidentally, at this time, since the throttle operating servomotor 41 is driven by the controller 28, the output from the engine 11 is increased, thereby increasing the amount of water discharged in a jet from the nozzle

deflector 13.

[0055]

When the auxiliary deflectors 51, 52 are thus turned, the flow of water discharged in a jet from the nozzle deflector 13 is changed in direction by the auxiliary deflectors 51, 52, so that the substantial steering angle is increased.

Therefore, when the rider applies increased force to the handlebars 6 in an attempt to make an even smaller turn (to make a turning radius even smaller) during a turn, for example, the turning radius of the hull becomes smaller. The rider can thus operate the boat in a natural manner without any concern for the throttle operation.

[0056]

The shape and number of the auxiliary deflectors 51, 52, the structure for turnably mounting the auxiliary deflectors 51, 52 to the nozzle deflector 13 and the driving constitution of the auxiliary deflectors 51, 52 are not limited to those according to the embodiment illustrated by an example but may be modified to another embodiment of similar function as appropriate.

[0057]

Further, in the case that the auxiliary deflectors 51, 52 are provided on the nozzle deflector 13, such an arrangement may be employed that the engine 11 is not controlled even if the load at which the steering control is to be started is applied to each of the load cells 36. In this case, the steerability of the boat can be improved by the auxiliary deflectors 51, 52 as long as the boat is running.

[0058]

(Fourth Embodiment)

An embodiment of the steering assist system according to the invention of Claim 5 to Claim 7 will be described in detail with reference to Fig. 9 to Fig. 11.

Fig. 9 is a perspective view of a portion of the steering assist system with rudders. Fig. 10 is a side view of the nozzle deflector and the rudders. Fig. 11 is a flowchart for explaining the operation of the controller for controlling the rudders. In the drawings, like or equivalent components are denoted by the same reference numerals as in Fig. 1 to Fig. 5, and detailed descriptions will be omitted as appropriate.

[0059]

A nozzle deflector 13 shown in Fig. 9 and Fig. 10 has rudders 61 provided on the lateral sides, respectively, to be vertically movable. In this embodiment, the rudders 61 are mounted to the nozzle deflector 13 to be vertically

turnable around a laterally extending turning shaft 62. To be specific, those rudders 61 are arranged such that they can change a horizontal angle between a projected position (the position shown in Fig. 10 by a solid line) at which they are projected below the nozzle deflector 13 at one ends and a retracted position at which they are oriented backwardly of the hull at one ends and made equal to the nozzle deflector 13 in height, as shown in Fig. 10 by a phantom line. Incidentally, in addition to such an arrangement that the horizontal angle can be changed, the rudders 61 may be vertically provided on the nozzle deflector 13 to be movable in parallel.

[0060]

The drive system of the rudders 61 is arranged such that a pulley 63 fixed to each of the rudders 61 is connected to a servomotor 65 through a pair of wires 64. The servomotor 65 is controlled by a controller 66, as will be described later, to turn the two rudders 61 simultaneously in the same direction.

[0061]

Each load cell 36 on the handlebars 6 side, and an engine speed sensor 27 provided in an engine 11 are connected to the controller 66. The controller 66 is arranged such that it turns the rudders 61 by an angle corresponding to the amount of load applied to each of the load cells 36 to lower the rear ends from the retracted position, when the engine speed detected by the engine speed sensor 27 is below a preset control start engine speed and when the load applied to each of the load cells 36 is above a preset steering assist starting load.

The control start engine speed is set at such a value that the amount of water discharged in a jet from the nozzle deflector 13 becomes small and the steerability of the boat is deteriorated. In this embodiment, the control start engine speed is set at 2000rpm. Incidentally, lowering the rudders 61 from the retracted position can be performed independently of the engine speed. Employing this arrangement can prevent the boat from drifting at the rear of the hull during a turn and further improve the steerability of the boat.

[0062]

Further, the steering assist starting load is set at the load applied to the corresponding load cell 36 when a handlebar 29 is turned right or left to the full (until the steering is regulated by a regulating means 34) and then further turned with greater force than usual required to turn the handlebar 29 in steering. Furthermore, the controller 66 controls the servomotor 65 so that the angle

formed when the rudders 61 are turned from the retracted position toward the projected position is approximately proportional to the amount of load applied to each of the load cells 36.

[0063]

Here, the operation of the controller 66 will be described with reference to the flowchart of Fig. 11. The controller 66 first detects the turning force of the handlebars 6 at step P1 and then determines whether or not the engine speed is lower than the control start engine speed at step P2. At this time, even if the load applied to either of the load cells 36 exceeds the steering assist starting load, in the case that the engine speed is higher than the control start engine speed, procedure returns to the step P1. On the other hand, when the load applied to either of the load cells 36 exceeds the steering assist starting load and when the engine speed is lower than the control start engine speed, the procedure goes to step P3.

[0064]

When the load applied to either of the load cells 36 is smaller than the steering assist starting load or when the engine speed is higher than the control start engine speed, the rudders 61 are held at the retracted position. Thus, when the boat runs in such a manner that the steerability is of little importance, such as when running straight or when making a large turn, the resistance of the water against the rudders 61 is reduced, so that the maximum speed and accelerability of the boat are reliably maintained.

[0065]

At the step P3, the controller 66 drives the servomotor 65 so that the turning angle of the rudders 61 is approximately proportional to the amount of load applied to either of the load cells 36. Thus, since the rudders 61 are lowered to the projected position shown in Fig. 10 by a solid line, for example, from the retracted position shown in Fig. 10 by a phantom line, and struck by the water, the steerability of the boat is improved by the rudders 61. That is, at this time, although the engine speed is relatively low and the amount of water discharged in a jet from the nozzle deflector 13 becomes small, the steerability of the boat is improved by the water striking the rudders 61.

[0066]

Therefore, according to the small planing boat of this embodiment, the steerability of the boat can be improved by the rudders 61 without operating the throttle. This makes it much easier for the rider to operate the boat as he/she

intended. Further, although this small planing boat is provided with the rudders 61, when the boat is running straight or making a large turn, for example, the rudders 61 are held at the position equal to the nozzle deflector 13 in height and the resistance of the water against the rudders 61 is reduced, so that the maximum speed and accelerability of the boat can reliably be maintained.

[0067]

The shape and number of the rudders 61, the structure for turnably mounting the rudders 61 to the nozzle deflector 13 and the driving constitution of the rudders 61 are not limited to those according to the embodiment illustrated by an example but may be modified to another embodiment of similar function as appropriate.

[0068]

In the foregoing embodiments, the load cells 36 are fixed to the mounting plate 33 in the deck 4 as an example. The load cells 36 may be arranged to be turnable along with a steering shaft 31, as shown in Fig. 12.

Fig. 12 is a sectional view of another embodiment of the regulating means. In the drawing, like or equivalent components are denoted by the same reference numerals as in Fig. 1 to Fig. 5, and detailed descriptions will be omitted as appropriate.

[0069]

The steering shaft 31 shown in Fig. 12 is made up of an upper steering shaft 31a with a handlebar 29 mounted at the upper end, and a lower steering shaft 31b connected to the lower end of the upper steering shaft 31 through the load cells 36. The upper steering shaft 31a is formed with a projecting press member 71, as a stopper piece, at the lower end, and the lower steering shaft 31b is integrally formed with a connecting box 72 for receiving the press member 71. Each of the load cells 36 is disposed in the connecting box 72 on the sides of the press member 71.

[0070]

The inside of the connecting box 72 is filled with the load cells 36 so that a probe 36a of one end of each of the load cells 36 is pressed against the press member 71 by the compressive force produced by a helical compression spring 73 of the other end. That is, the force applied to the handlebar 29 by the rider is transmitted to the connecting box 72 (the lower steering shaft 31b) from the press member 71 of the upper steering shaft 31a through either of the load cells 36 and either of the helical compression springs 73.

In Fig. 12, reference numeral 74 denotes each pressure receiving member for regulating the turning of the

connecting box 72. The pressure receiving members 74 are fixed to a deck 4.

Such an arrangement of the regulating means also produces the same effect as with the first and the second embodiments.

[0071]

In the foregoing first to third embodiments, the opening of the throttle valves 24 is changed by the servomotor 41, as an example, in order to increase the output of the engine 11. In place of controlling the throttle valves 24, such an arrangement may be employed that auxiliary air intake passages as bypasses are provided around the throttle valves 24 and electromagnetic open/close valves placed midway in the auxiliary air intake passages are opened at the time of steering control. Also, in the foregoing first to fourth embodiments, operating elements such as the throttle valves 24, auxiliary deflectors 51, 52 and rudders 61 are turned by the angle according to the amount of load applied to each of the load cells 36, as an example. Those operating elements may be arranged to be turned by a certain angle only, with on/off switches.

[0072]

(Fifth Embodiment)

The foregoing embodiments illustrate examples of the invention for use in the steering system of the small planing boat. The invention, however, can be used for the steering system of an outboard motor, as shown in Fig. 13

Fig. 13 is a perspective view of the steering assist system for an outboard motor. In the drawings, like or equivalent components are denoted by the same reference numerals as in Fig. 1 to Fig. 12, and detailed descriptions will be omitted as appropriate.

[0073]

In Fig. 13, reference numeral 81 denotes a steering system for an outboard motor. The steering system for an outboard motor 81 is similar to the one disclosed in JP-A-H06-107286, for example, and is arranged such that operating a steering wheel 82 provided in the hull (not shown) causes a hydraulic cylinder 83 to swing a steering arm 85 of an outboard motor 84 right and left.

[0074]

The steering wheel 82 is provided with a pinion 86 and arranged to move a rack 87 meshed with the pinion 86 right and left. When the movement of the rack 87 is transmitted to a hydraulic switching device 89 through a cable 88, a hydraulic circuit in the hydraulic cylinder 83 is switched by the hydraulic switching device 89 to swing the steering

arm 85 in the direction corresponding to the steering direction.

[0075]

The rack 87 is formed with a projecting load cell arm 35 at one end, and the movement of the rack 87 is regulated by the load cell arm 35 coming in surface contact with each load cell 36. This embodiment is arranged such that a controller 28 and throttle operating servomotor 41 of a steering assist system 2 are provided in the outboard motor 84 and throttle valves (not shown) of the outboard motor 84 are increased in opening when the load applied to either of the load cells 36 exceeds a preset load. The method of controlling the throttle valves is the same as that in the foregoing embodiments. Incidentally, the load cell arm 35 may be provided in a connecting bar 83b fixed to a piston rod 83a of the hydraulic cylinder 83, in place of in the rack 87.

[0076]

In the steering control system according to the invention thus provided in the outboard motor, when the steering wheel 82 is turned right or left by a maximum turning angle and then further turned with greater force than usual, the force is detected by the corresponding load cell 36 to increase the thrust produced by the outboard motor 84. Therefore, the rider can operate the boat driven by the outboard motor 84 in a natural manner. Incidentally, in the use of the invention in the boat driven by the outboard motor 84, the steering system is not limited to the one according to this embodiment but may be modified as appropriate.

[0077]

[Effects of the Invention]

According to the invention as described above, when the steering system is turned either right or left by a maximum turning angle and then further turned with greater force than usual, the force is detected by the corresponding load cell to increase the thrust produced by a propulsion device. Therefore, the rider can operate the boat in a natural manner.

[0078]

According to the invention of Claim 2, when the handlebars are turned either right or left by a maximum turning angle and then further turned with greater force than usual, the force is detected by the corresponding load cell to increase the thrust produced by a water jet propulsion device. Therefore, the rider can operate the boat with the water jet propulsion device mounted, in a natural manner.

[0079]

According to the invention of Claim 3, when the handlebars are turned either right or left by a maximum turning angle and then further turned with greater force than usual, the amount of water discharged in a jet from the nozzle deflector is increased and the flow of the discharged jet of water is changed in direction by the auxiliary deflectors, so that the substantial steering angle is increased. Therefore, since the running direction of the boat is swiftly changed, the rider can further smoothly operate the boat.

[0080]

According to the invention of Claim 4, when the steering system is turned either right or left by a maximum turning angle and then further turned with greater force than usual, the force is detected by the corresponding load cell and the flow of water discharged in a jet from the nozzle deflector is changed in direction by the auxiliary deflectors, so that the substantial steering angle is increased. Therefore, the steerability of the boat is further improved during the running, thereby making it much easier for the rider to operate the boat as he/she intended.

[0081]

According to the invention of Claim 5, when the steering system is turned either right or left by a maximum turning angle and then further turned with greater force than usual, the force is detected by the corresponding load cell to lower the rudders. Meanwhile, when the boat runs with no steering force produced by the steering system, the rudders go back up to the retracted position. Therefore, since the rudders are back up to the retracted position when the boat is running with no steering force produced, even if the boat runs in shallow waters, the rudders are prevented from contacting obstacles under the sea. Thus, the rudders cause no problem in the shallow water running.

[0082]

According to the invention of Claim 6, when the handlebars are turned either right or left by a maximum turning angle and then further turned with greater force than usual, the force is detected by the corresponding load cell to lower the rudders, so that the steerability is improved. Therefore, the rider can operate the boat with the water jet propulsion device mounted, in a natural manner.

[0083]

According to the invention of Claim 7, since the rudders are turned right and left along with the nozzle

deflector, an operating mechanism especially for turning the rudders right and left can be eliminated. Therefore, the steerability of the boat can be improved while cost reduction is effected.

[Brief Description of the Drawings]

Fig. 1 is a plan view of a small planing boat equipped with a steering assist system according to the invention;

Fig. 2 is a perspective view of a constitution of the steering assist system according to the invention;

Fig. 3 is a block diagram of the constitution of the steering assist system according to the invention;

Fig. 4 is a flowchart for explaining the operation of the steering assist system according to the invention;

Fig. 5 is a flowchart for explaining another embodiment of the steering assist system;

Fig. 6 is a perspective view of a constitution of the steering assist system equipped with auxiliary deflectors;

Fig. 7 is a perspective view, on an enlarged scale, of the auxiliary deflectors;

Fig. 8 is a plan view for explaining the operation of a nozzle deflector and the auxiliary deflectors;

Fig. 9 is a perspective view of a portion of the small planing boat with rudders;

Fig. 10 is a side view of the nozzle deflector and the rudders;

Fig. 11 is a flowchart for explaining the operation of a controller for controlling the rudders;

Fig. 12 is a sectional view of another embodiment of a regulating means; and

Fig. 13 is a perspective view of the steering assist system for an outboard motor.

[Explanation of Reference Numerals]

1: small planing boat 2: steering assist system 3: hull
7: water jet propulsion device 6: handlebars 11: engine
13: nozzle deflector 16: helm 24: throttle valve
28: controller 31: steering shaft 31a: upper steering shaft
31b: lower steering shaft 33: mounting plate
34: regulating means 35: load cell arm 36: load cell
41: servomotor 48: servomotor controller
51, 52: auxiliary deflector 61: rudder 71: press member
72: connecting box 84: outboard motor>

[Document Name] Abstract
[Abstract]
[Object] To provide a steering assist system for a boat to assist the rider to operate the boat in a natural manner without any concern for throttle operation.
[Solution] A regulating means 34 for regulating the turnable range of handlebars 6 is provided. The regulating means 34 is constituted of a stopper piece (a load cell arm 35) adapted to be turned along with the handlebars 6, pressure receiving members (a mounting plate 33) for stopping the movement of the stopper piece, and load cells 36 interposed therebetween. A steering control system 2 is provided for increasing an output of an engine 11 in a water jet propulsion device 7 according to an output from each of the load cells 36.
[Selected Drawing] Fig. 2
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